

CONSTELLATION-X MICROCALORIMETER DEVELOPMENT

NASA Grant No. NAG5-11893

Annual Report Nos. 1 and 2

For Period 1 April 2002 through 31 March 2004

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June 2004

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Annual Report
NTD Ge-Based Microcalorimeter
Development for Constellation-X

Grant NAG5-11893
January 31, 2004

Submitted by:

Eric Silver (SAO)

with input from:

Gerry Austin (SAO)

Jeff Beeman and Don Landis (LBNL)

Norm Madden (LLNL)

Discussion Topics

Review concept for NTD array construction

Tested revised fabrication technique

Simpler construction

More rugged

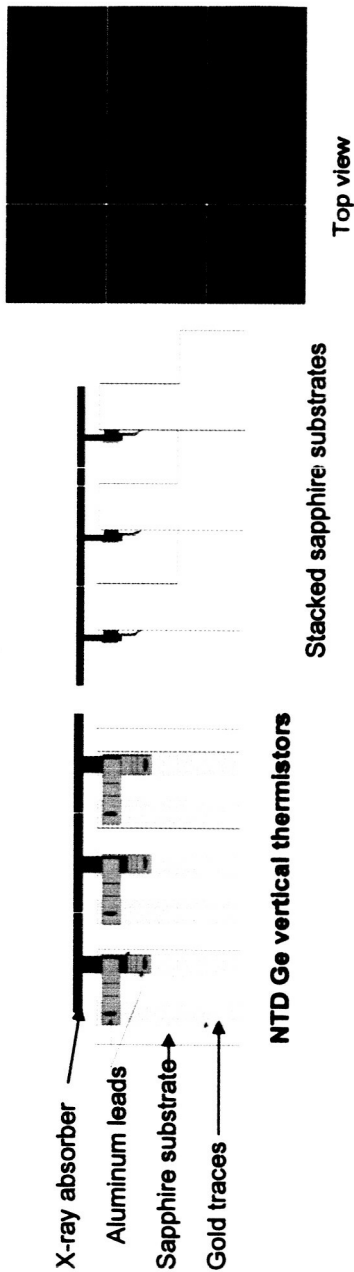
Easier to control thermal properties

Development status

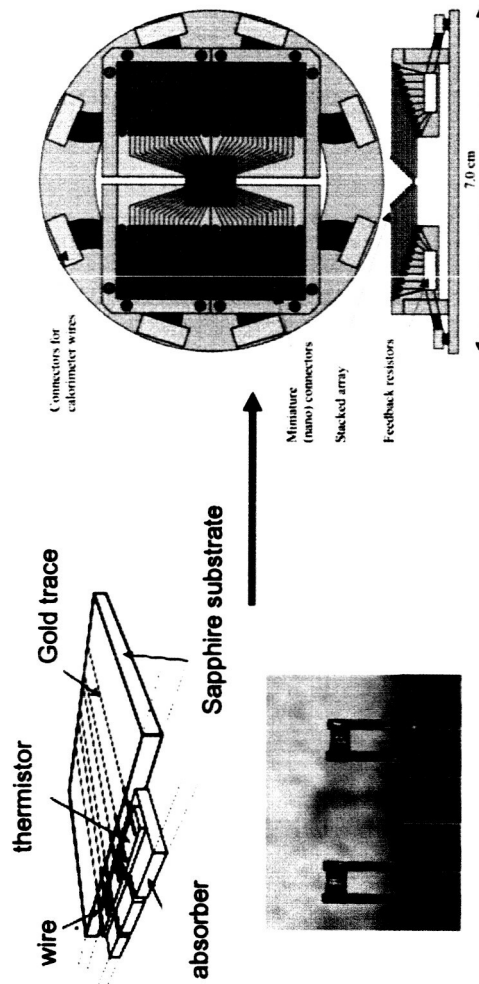
Related Cryogenic infrastructure

Previous *Flying Lead* Construction Techniques

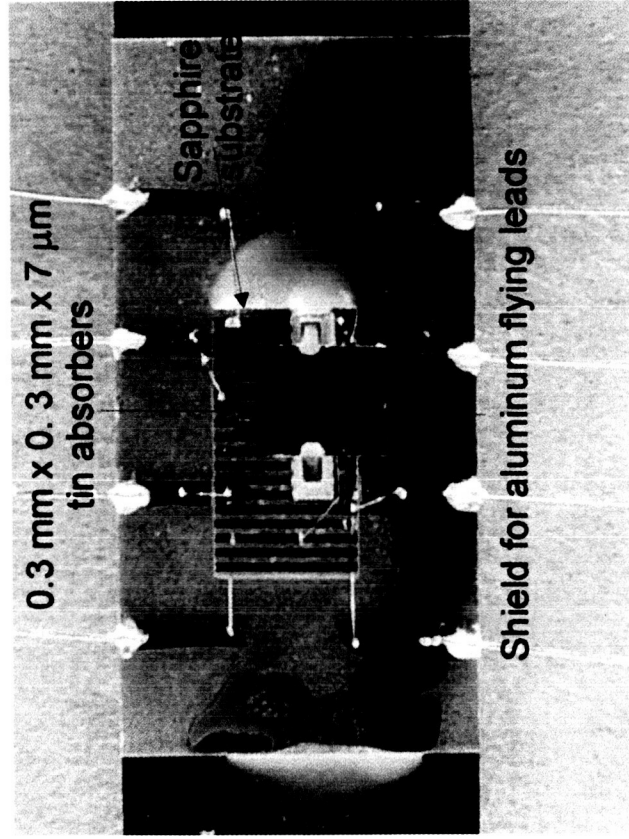
Schematic of stacked 3 x 3 array



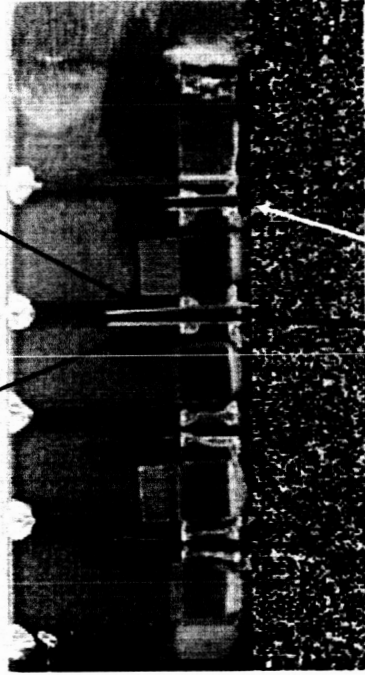
NTD Ge Flatpack thermistors



Prototype 1 x 4 NTD Germanium
Microcalorimeter array

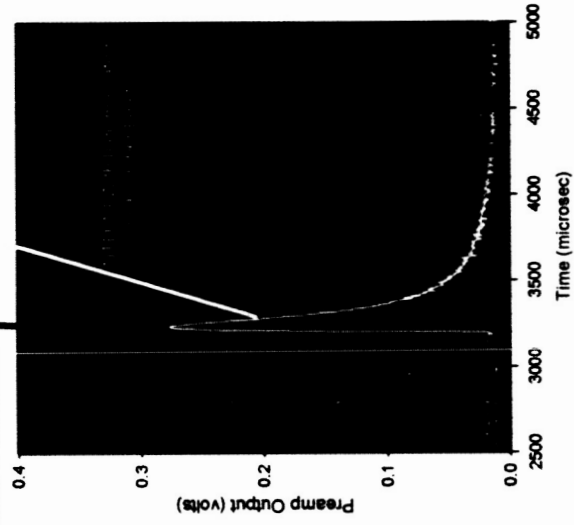


Prototype NTD19 Flatpack Thermistor Using In-coated Glass Fiber leads



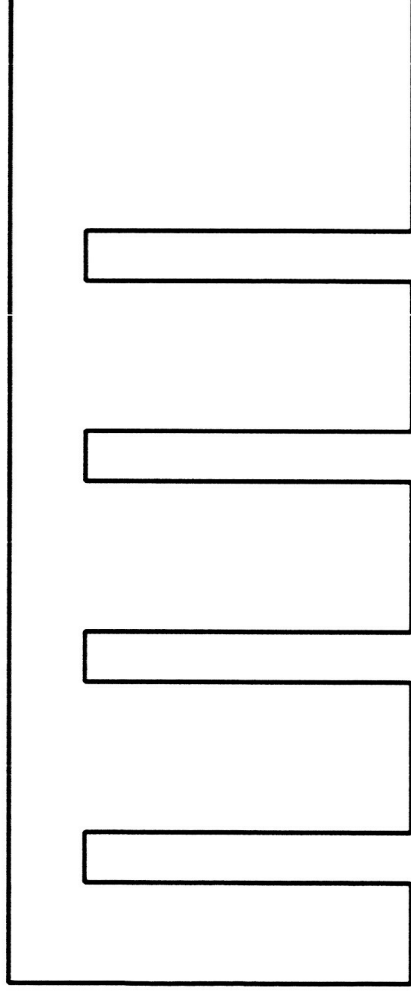
All Microcalorimeter components are the same as always (i.e., NTD19 or NTD17, 7 μm Sn absorber) except for the In-coated glass leads

Amplitude and temporal profile same as in previous good devices

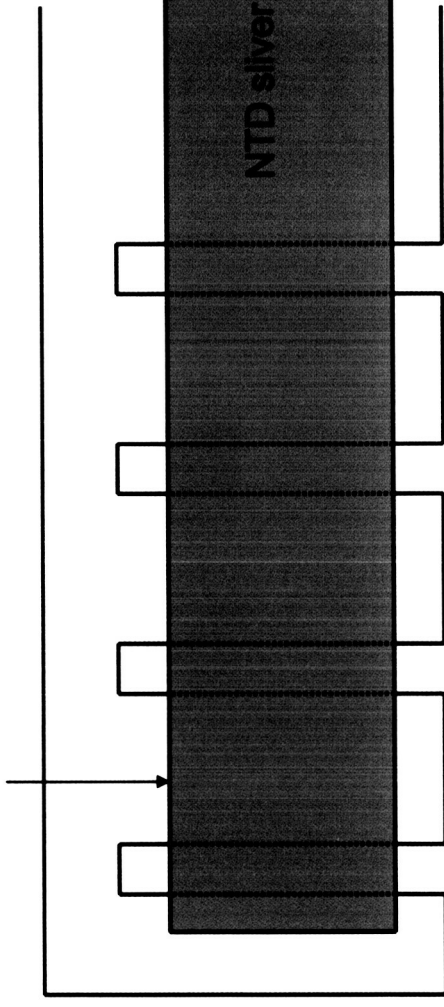


Fabricating NTD 17 Vertical thermistor Arrays

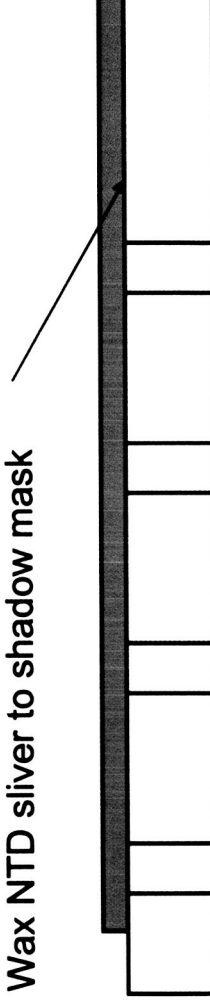
Fabricate Silicon shadow mask with correct inter-electrode spacing



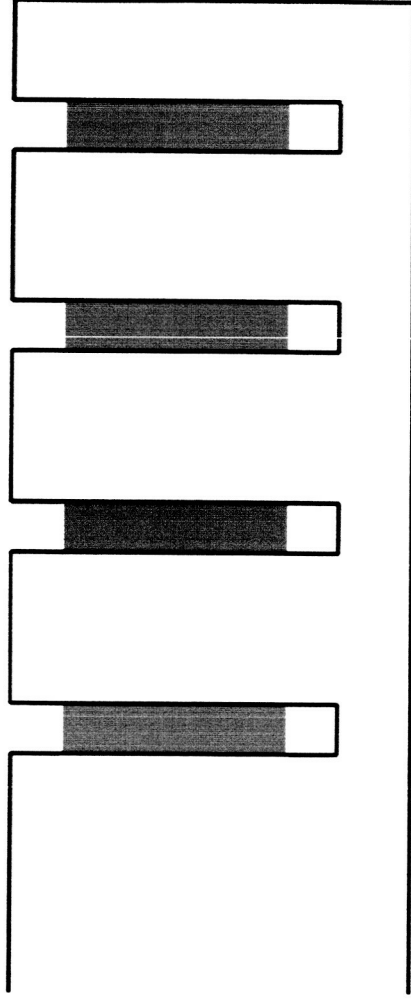
Polish NTD Ge to 25 microns thick (chemochemical polish)



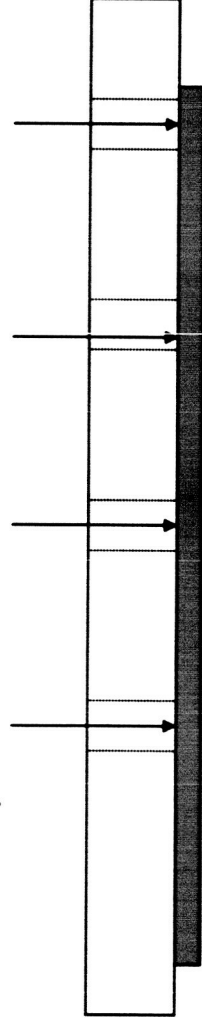
Wax NTD silver to shadow mask



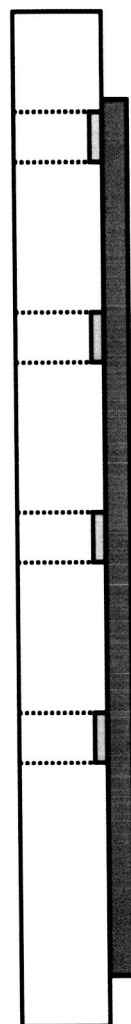
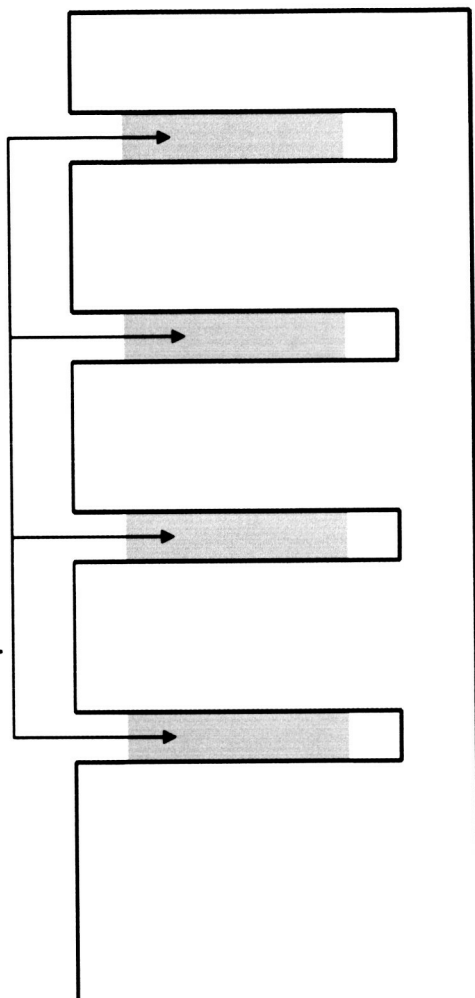
Turn over the mask and NTD sliver



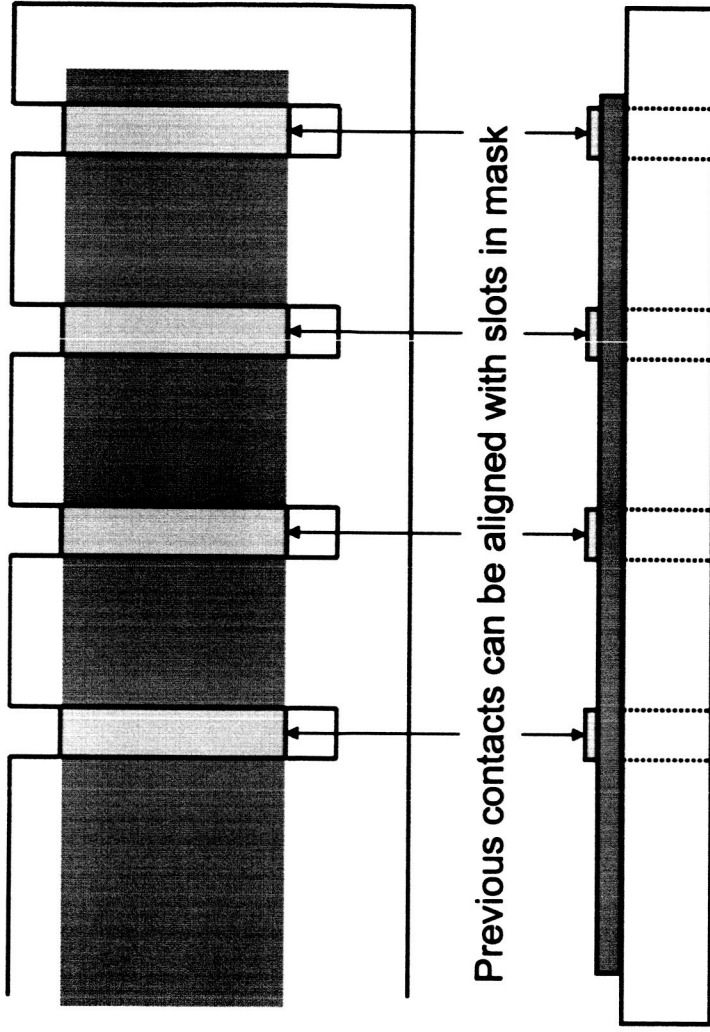
Ion implant with B^+ and metallize with Ti and In



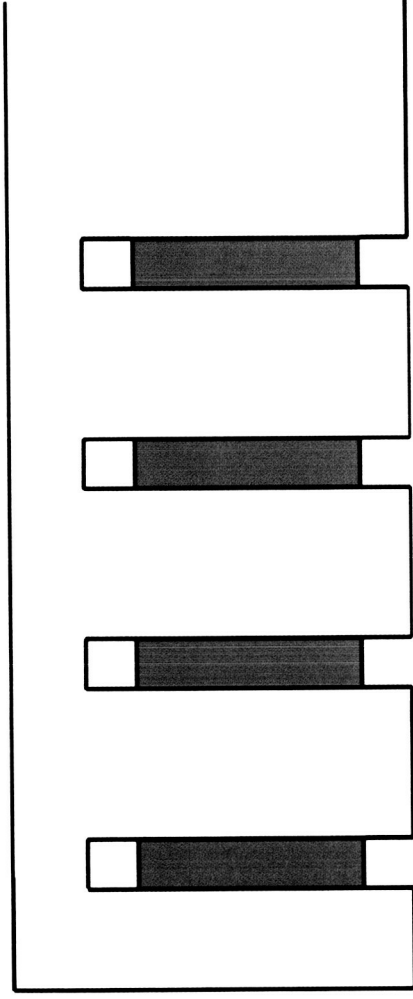
Implants and electrical contacts



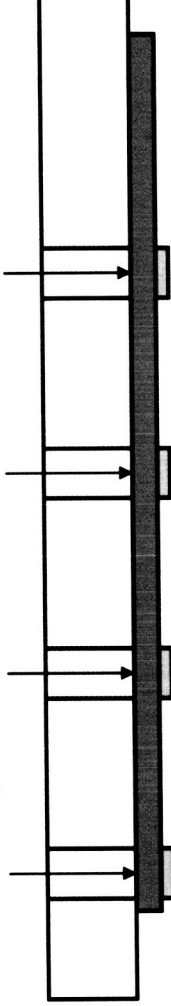
Release the NTD chip with hot solvent, fully clean, flip over and remount on shadow mask



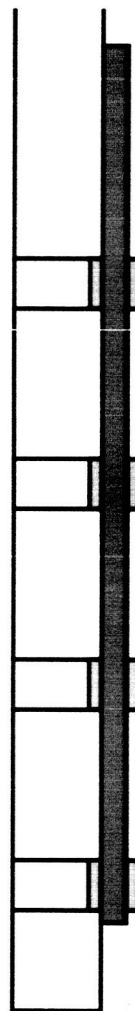
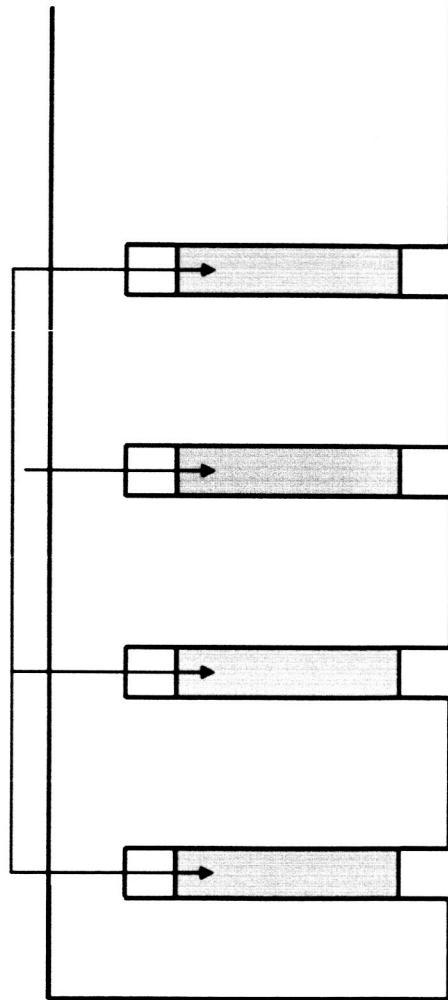
Flip over the mask and NTD sliver



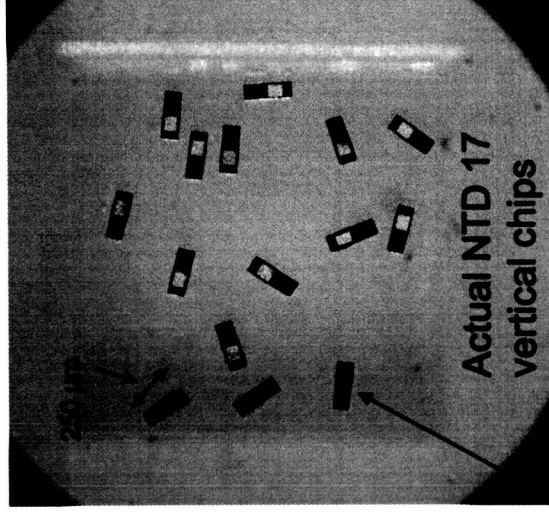
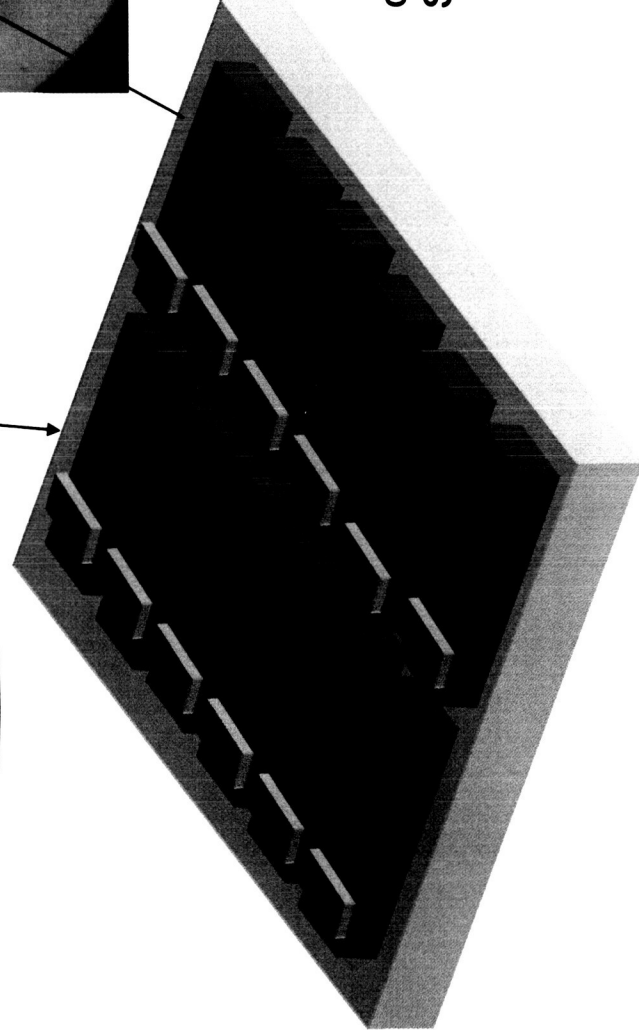
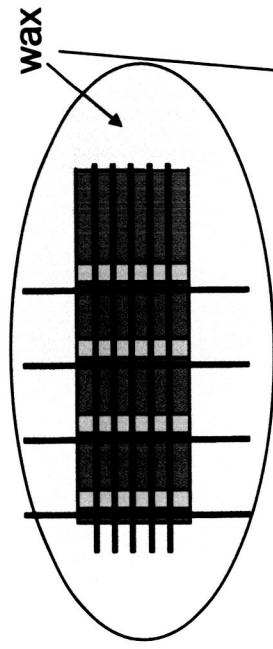
Ion implant with B^+ and metallize with Ti and In



Implants and electrical contacts on the back side

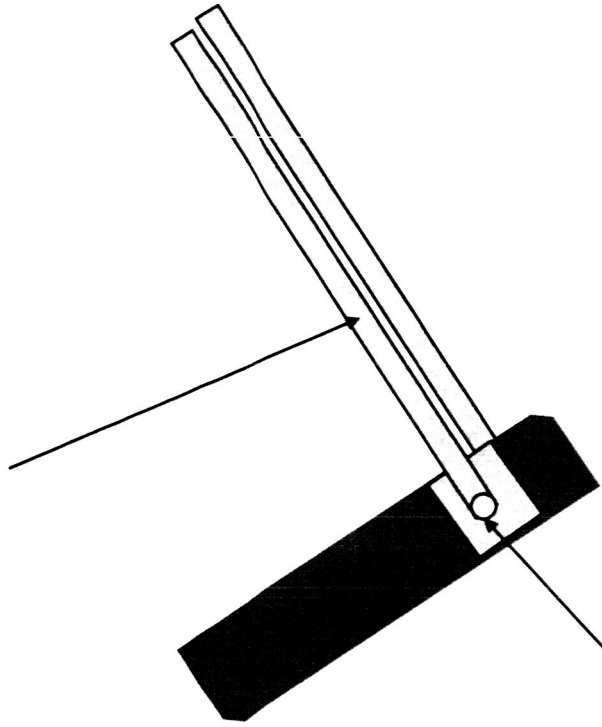


Wafer is removed, waxed to Si carrier wafer
and then diced

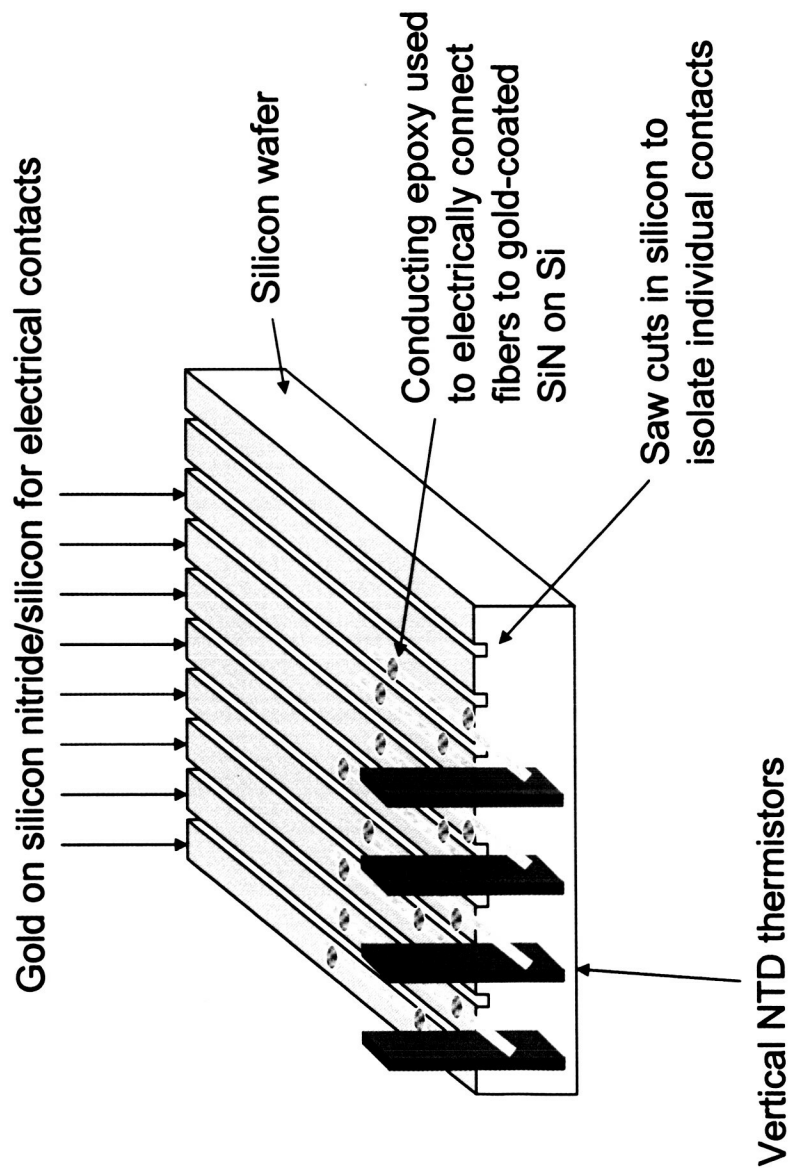


After brief etching to
remove saw damage,
devices are released from
Si wafer with hot solvents.

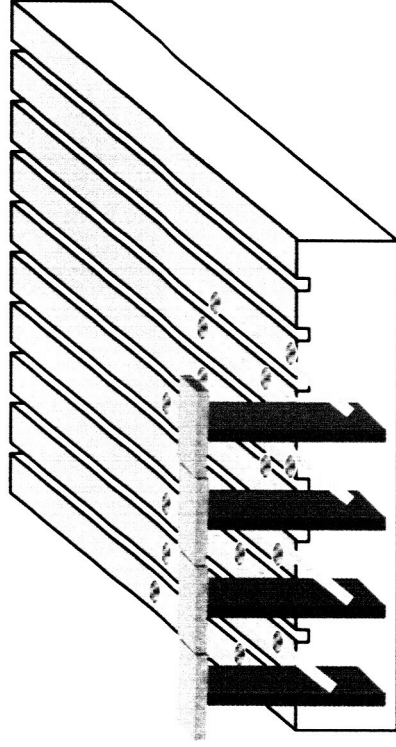
Glass fibers are coated with Ti and In (2 μm thickness)



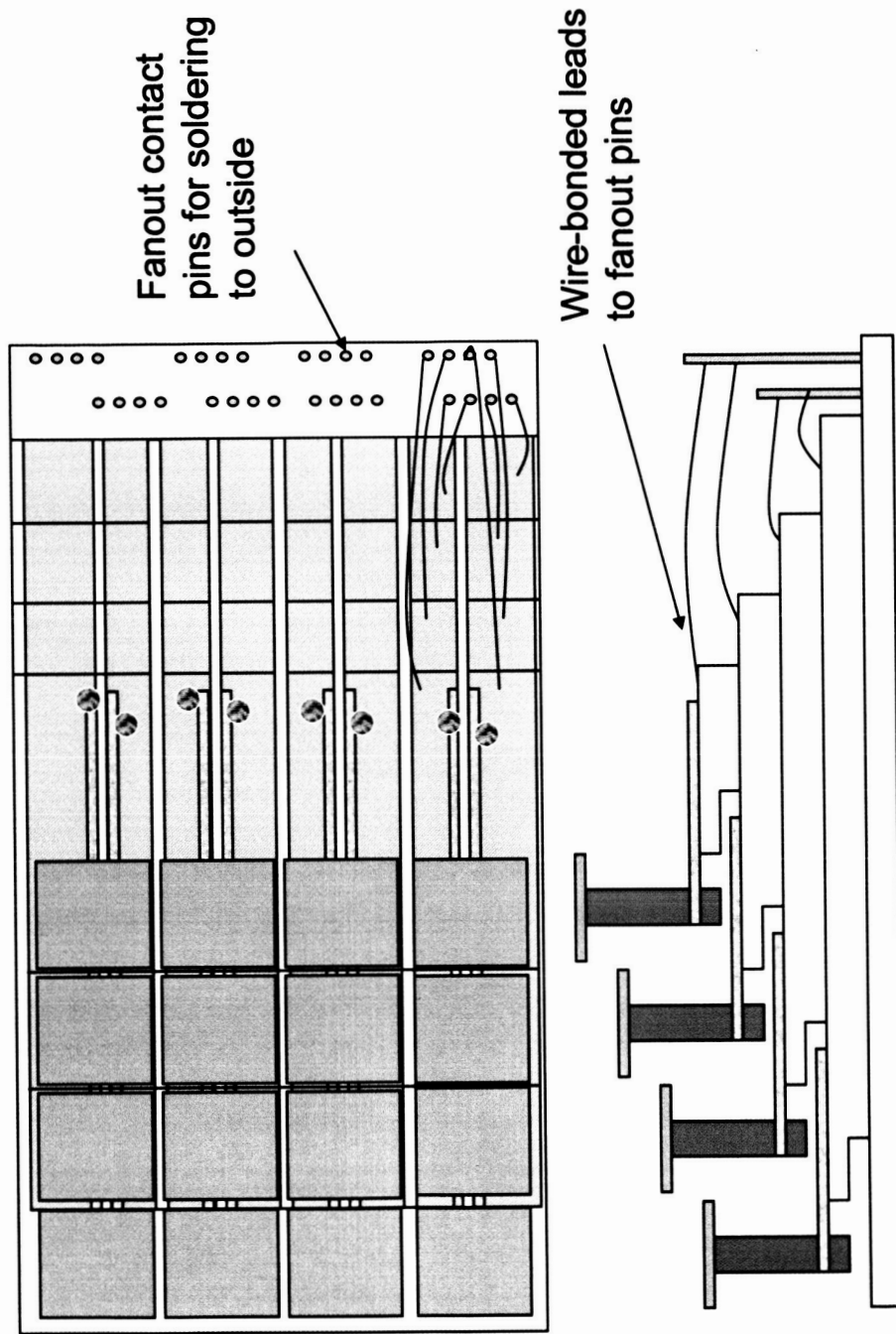
Fibers are bump-bonded with specific known force



1 x n array of vertical NTD thermistors with tin x-ray absorbers



1 x 4 linear arrays stacked to form a 4 x 4 array

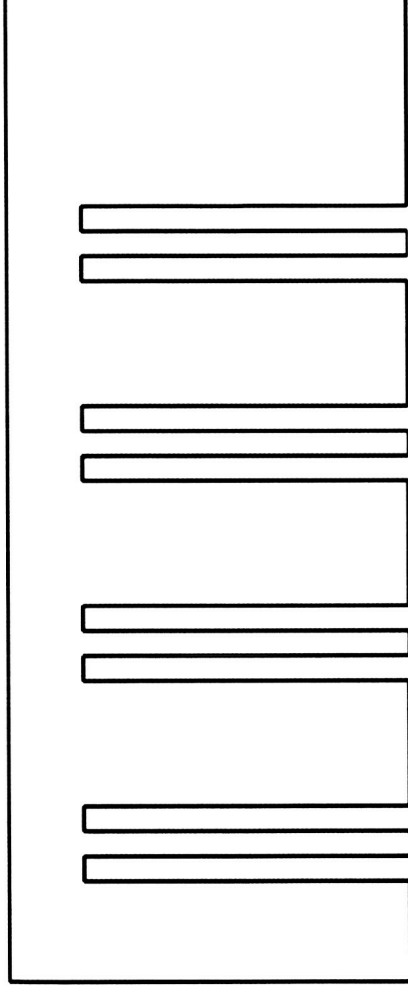


Fabricating NTD 19

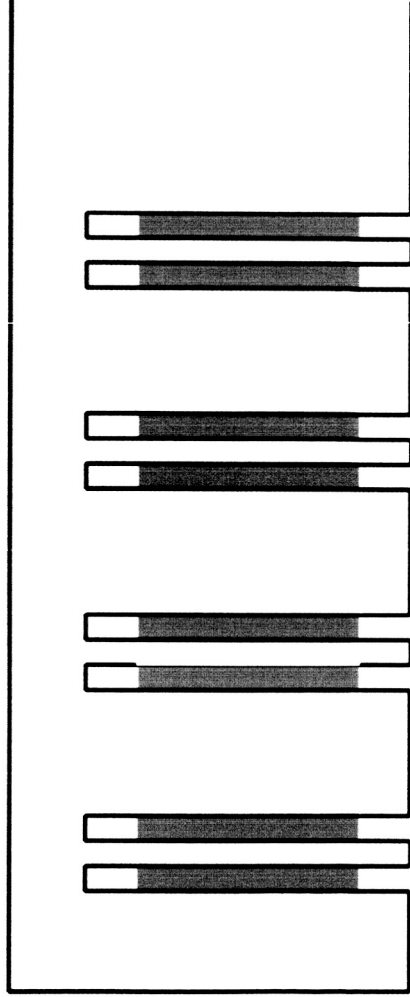
***Flatpack* thermistor**

Arrays

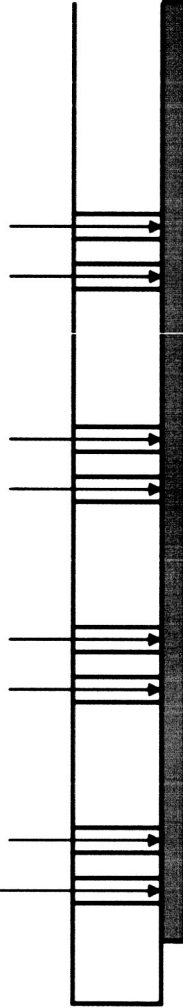
Fabricate Silicon shadow mask with correct inter-electrode spacing



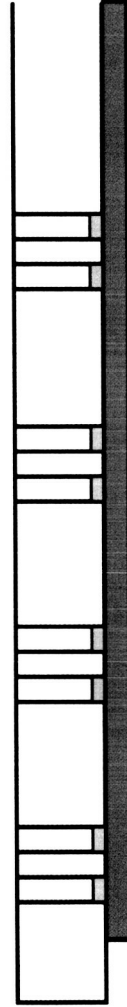
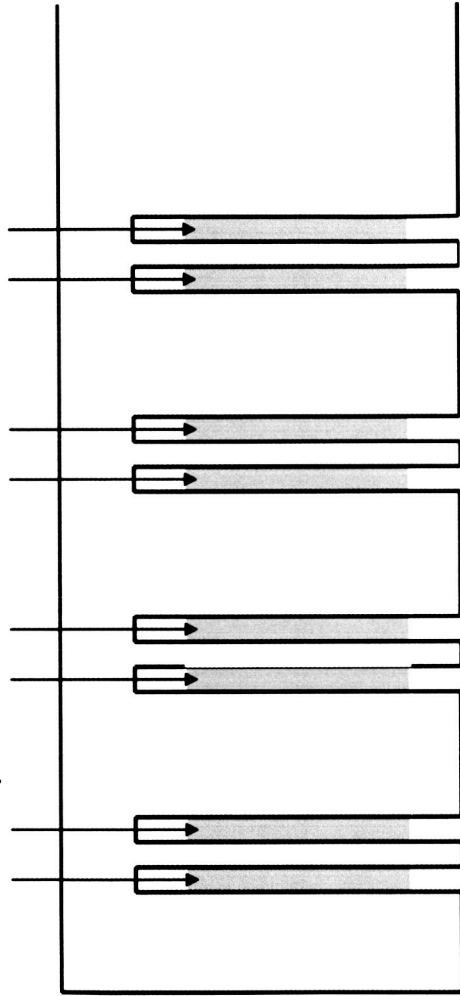
Polish NTD Ge to 25 microns thick (chemochemical polish)



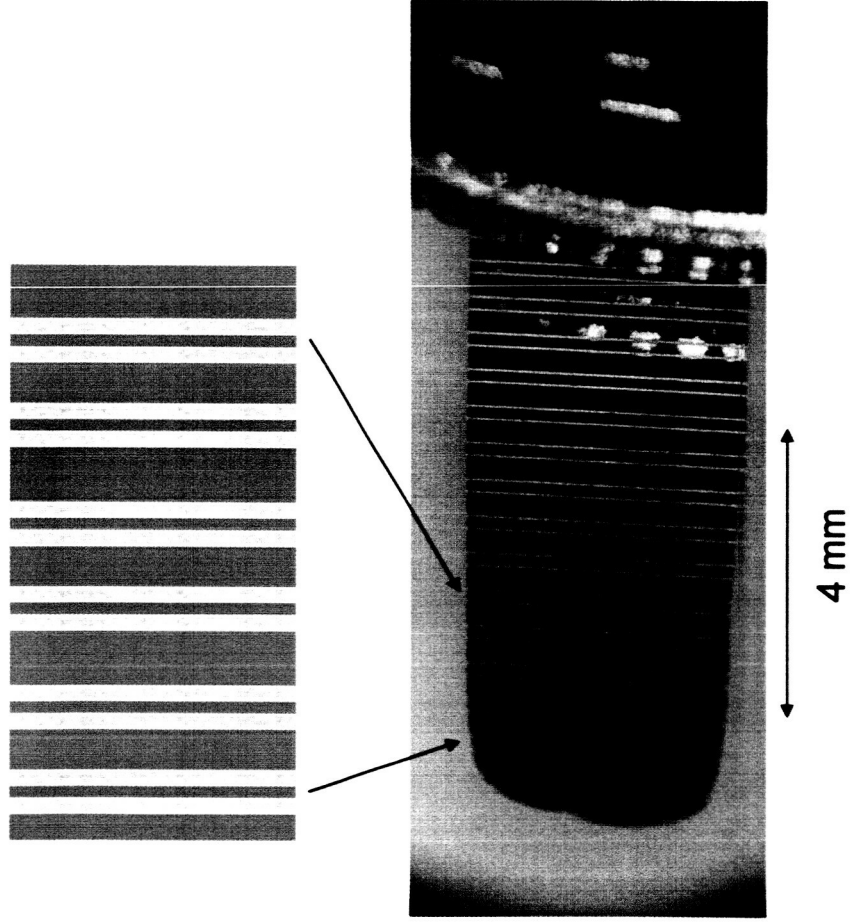
Ion implant with B⁺ and metallize with Ti and In



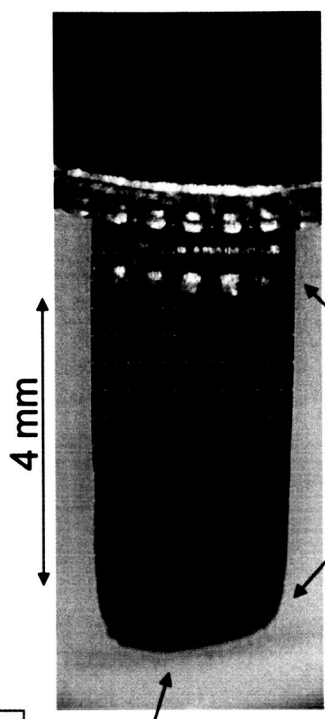
Implants and electrical contacts



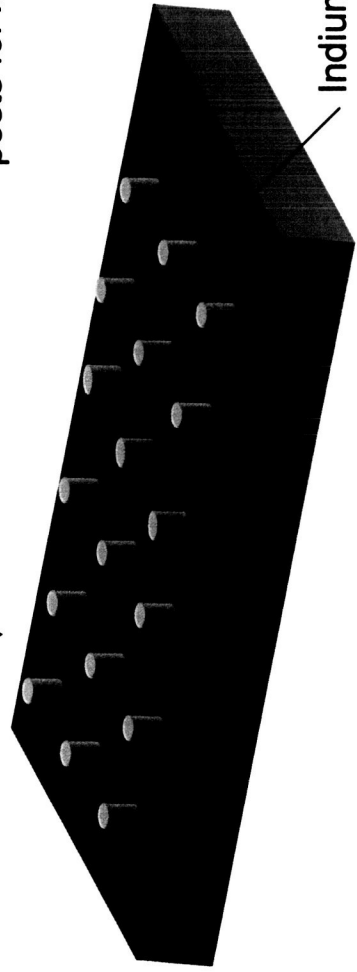
Contact Side of NTD 19 Flatpack thermistor wafer



**X-Ray absorber Side of NTD 19
Flatpack thermistor**

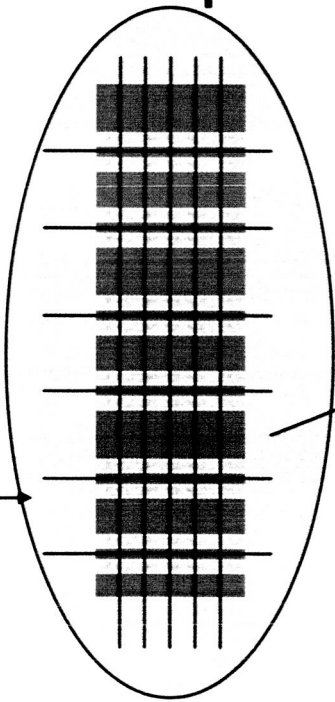


15 x 16 array of thermistors showing indium posts for x-ray absorbers



Indium support posts for x-ray absorber (bump bonded directly or glued)

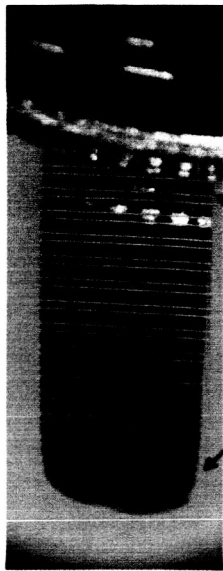
Wafer is waxed to Si carrier wafer
and then diced



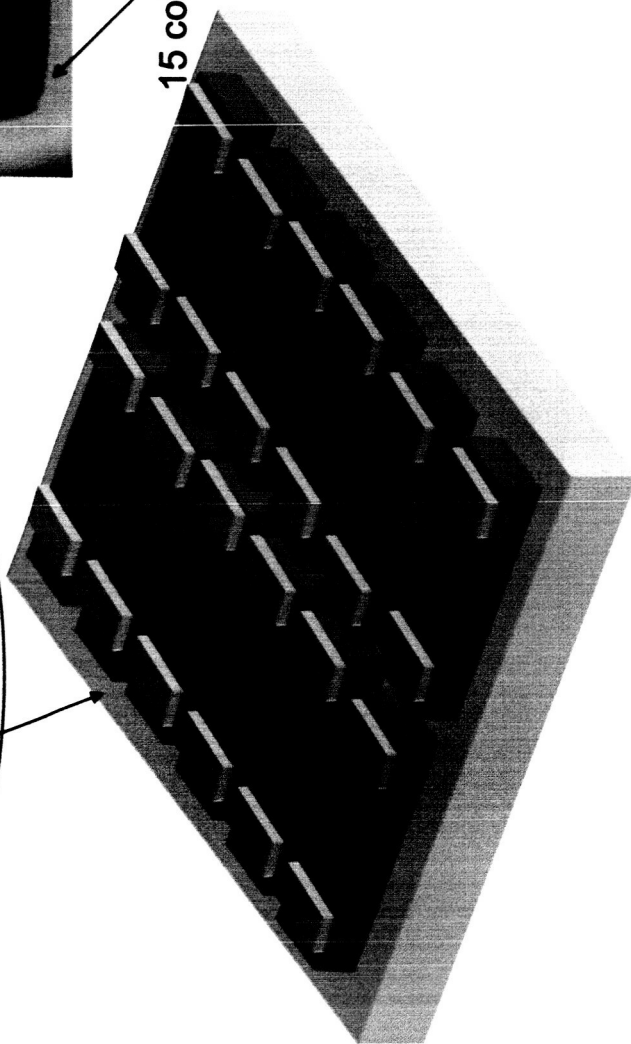
**Contact Side of NTD 19
Flatpack thermistor**

Processed NTD 19 wafer ready for slicing

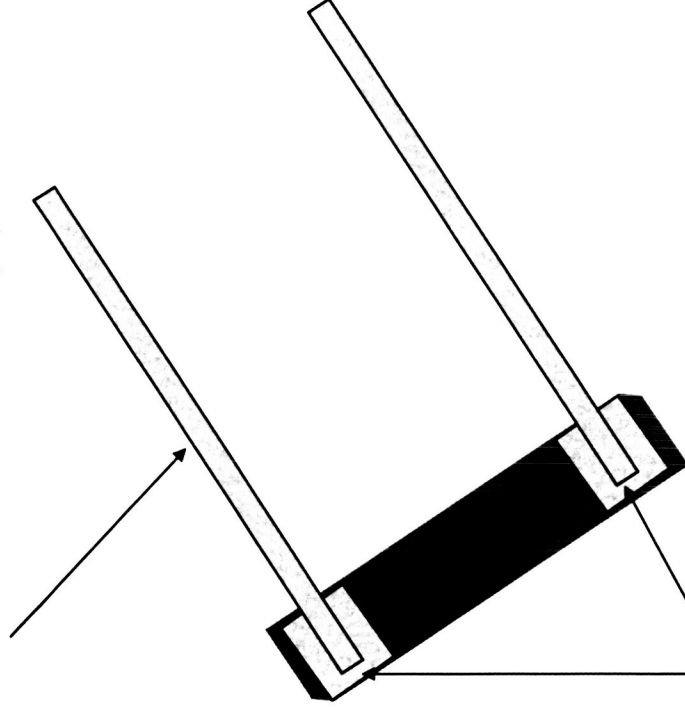
4 mm



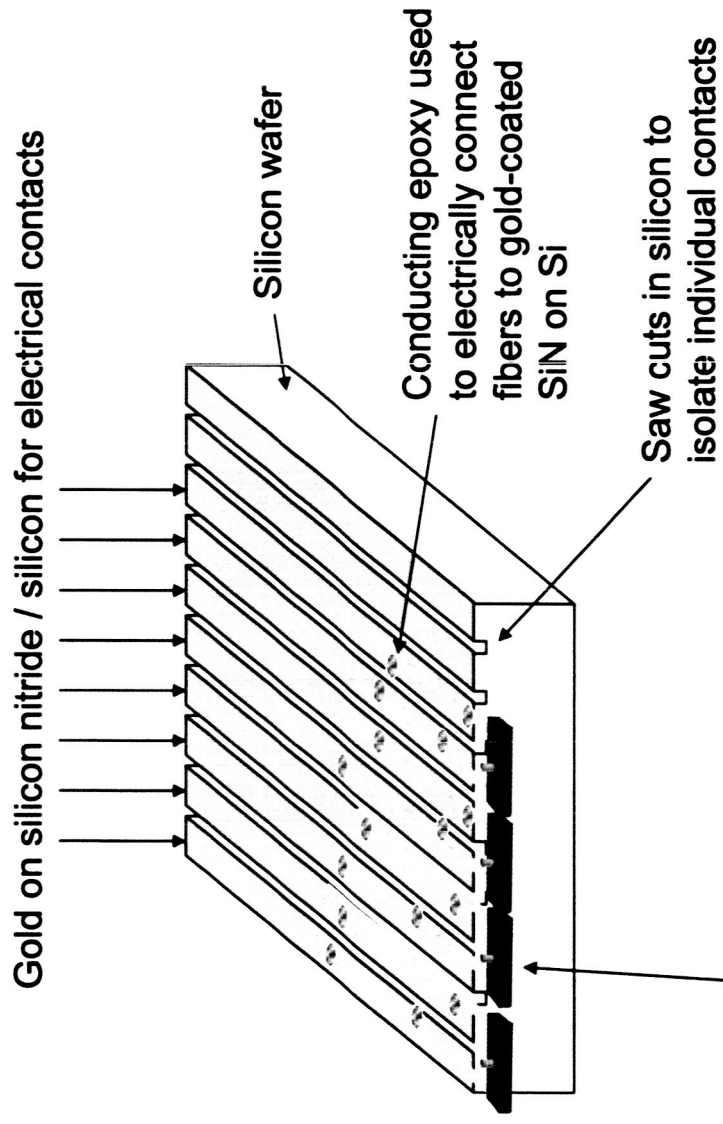
15 columns of B+ implanted,
indium contacts



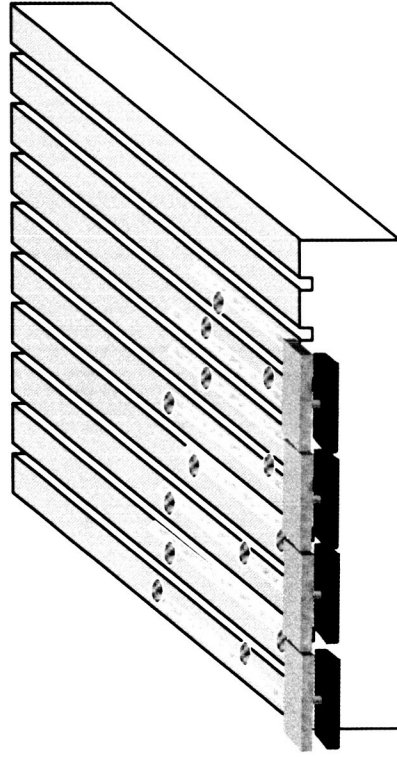
Glass fibers are coated with Ti and In (2 μm thickness)



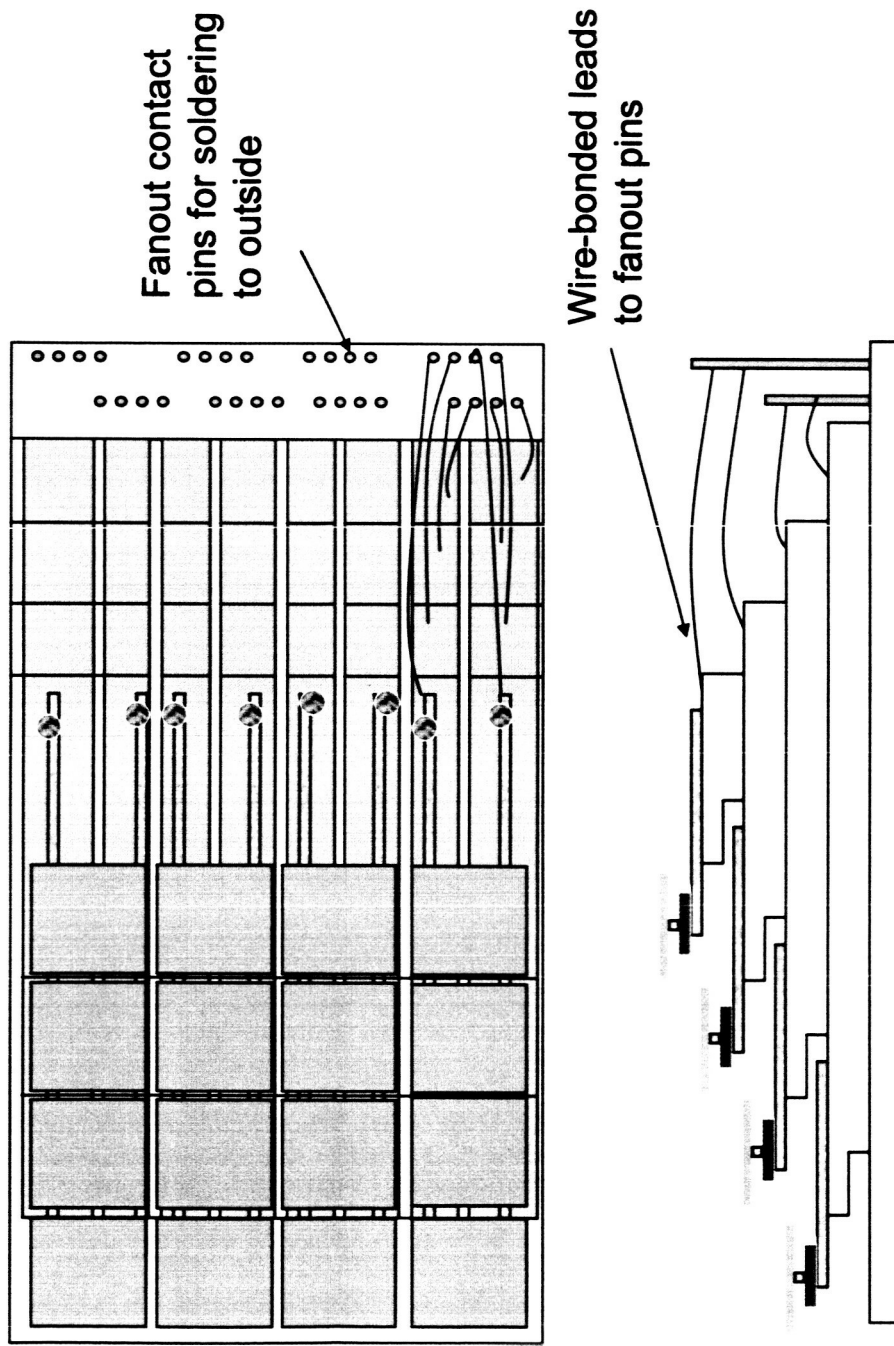
Fibers are bump-bonded with specific known force



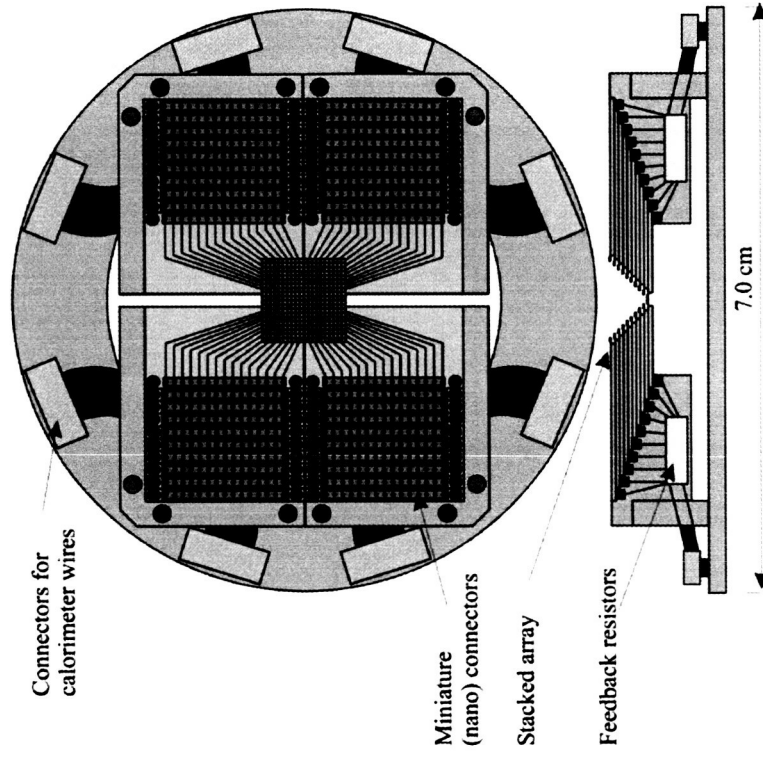
1 x n array of *Flatpack* NTD thermistors with tin x-ray absorbers



1 x 4 linear arrays stacked to form a 4 x 4 array



20 x 20 array of NTD –based microcalorimeters



Accomplishments

- Fabricate and test 1 x 4 array of vertical NTD17 Ge-based microcalorimeters
- Developed new construction technique for producing numerous pixels
- Temporal profile of new thermistor shows fast risetime (30 - 60 μ s) and fast decay time (300 μ s).
- We are completing the assembly of a cryostat with a 2-stage ADR (modeled after the one we have operating at NIST, Gaithersburg on their EBIT) that will allow us to operate 16 detector channels simultaneously.